1

1   ROUTE GUIDANCE SYSTEM

2

3   Background of the Invention

4

5   In-vehicle route guidance systems are known.

6   However, such systems typically include their own

7   on-board map databases. Since large amounts of data

8   are generally required to describe maps, traditional

9   in-vehicle route guidance systems generally include

10   storage devices with substantial storage capacities

11   to hold the relevant map data.

12

13   European Patent Application EP 1262936 describes a

14   route guidance system comprising an in-vehicle

15   device and a central route advisory system. EP

16   1262936 describes how the driver of a vehicle

17   contacts the central route advisory system and

18   indicates a required destination. The central route

19   advisory system is also informed of the current

20   position of the vehicle by the in-vehicle device.

21   The central route advisory system determines the

22   optimal route to the required destination and

2

1   transmits details of the route to the in-vehicle

2   device in a single compressed data message.

3

4   EP 1262936 further describes how during the journey,

5   the in-vehicle device issues audible instructions to

6   the driver as the vehicle passes route key-points

7   along the optimal route. The instructions advise

8   the user of future manoeuvres which the user will be

9   required to undertake at junctions, roundabouts etc.

10

11 Summary of the Invention

12

13 According to the invention there is provided a route

14 guidance system comprising an in-vehicle device and

15 a central route advisory system in which the in-

16 vehicle device comprises an audio emitter and a

17 visual display unit adapted to provide audio and

18 visual instructions to a user to perform manoeuvres

19 required to complete an optimal route, wherein the

20 optimal route is transmitted by the central route

21 advisory system to the in-vehicle device in response

22 to a route request from the user to a human operator

23 in the central route advisory system to a specified

24 destination.

25

26 Preferably, the visual display unit is a monochrome

27 display.

28

29 Preferably, the system comprises a means for

30 displaying on the visual display unit a junction or

31 roundabout as the vehicle approaches it.

32

1   Desirably, the system comprises a means for
2   displaying on the visual display unit junctions as
3   pictographs.
4
5   Desirably, the system comprises a means of
6   displaying on the visual display unit roundabouts as
7   pictographs.
8
9   Preferably, the system comprises a means for
10 indicating on the displayed pictograph the required
11 manoeuvre.
12
13 Preferably, the system comprises a means for
14 supplementing the visual instructions to perform a
15 manoeuvre with audible instructions to perform a
16 manoeuvre.
17
18 Desirably, the visual display unit provides a means
19 of initiating an automatic route request in respect
20 of a stored destination.
21
22 Desirably, the system comprises a means for
23 displaying on the visual display unit the proximity
24 of speed-cameras.
25
26 Alternatively, the visual display unit is a colour
27 display unit.
28
29 Preferably, the system comprises a means for
30 displaying on the colour display unit coloured road-
31 maps of a particular region.
32

1   Preferably, the system comprises a means for
2   superimposing onto the coloured road-maps the
3   current position of the car.
4
5   Preferably, the system comprises a means for
6   superimposing onto the coloured road-maps the
7   pictograph of a junction or roundabout.
8
9   Desirably, the system comprises a means for
10   providing a user-interface on the colour display
11   unit and a means for enabling the user to a make
12   telephone call.
13
14   Desirably, the system comprises a means for
15   providing a user-interface on the colour display
16   unit and a means for enabling the user to receive a
17   telephone call.
18
19   Preferably, the system comprises a means for
20   providing a user-interface on the colour display
21   unit and a means for enabling the user to receive a
22   text-message.
23
24   According to a second aspect of the invention there
25   is provided a route guidance system comprising an
26   in-vehicle device and a central route advisory
27   system in which the in-vehicle device comprises
28   units adapted to provide instructions to a user to
29   perform manoeuvres required to complete an optimal
30   route, wherein the optimal route is determined by
31   the central route advisory system using real-time
32   historical traffic data acquired from monitored

1   routes together with archive data acquired from non-
2   monitored routes and transmitted by the central
3   route advisory system to the in-vehicle device in
4   response to a route request from the user to a human
5   operator in the central route advisory system to a
6   specified destination.
7
8   According to a third aspect of the invention there
9   is provided a route guidance system comprising an
10   in-vehicle device and a central route advisory
11   system in which the in-vehicle device comprises
12   units adapted to provide instructions to a user to
13   perform manoeuvres required to complete an optimal
14   route, wherein the optimal route is calculated by
15   the central route advisory system using a traffic
16   forecasting model and transmitted by the central
17   route advisory system to the in-vehicle device in
18   response to a route request from the user to a human
19   operator in the central route advisory system to a
20   specified destination.
21
22   Preferably, the traffic forecasting model is time
23   dependent.
24
25   Preferably, the central route advisory system
26   comprises a means for predicting future traffic
27   conditions based on the time at which the route
28   request was received together with the time
29   dependent traffic forecasting model.
30
31   According to a fourth aspect of the invention there
32   is provided a route guidance system comprising an

1   in-vehicle device and a central route advisory

2   system in which the in-vehicle device comprises

3   units adapted to provide instructions to a user to

4   perform manoeuvres required to complete an optimal

5   route, wherein the optimal route is calculated by

6   the central route advisory system taking into

7   account the previous travelling direction of the

8   vehicle, in response to a route request from the

9   user to a human operator in the central route

10   advisory system to a specified destination, and the

11   optimal route is transmitted by the central route

12   advisory system to the in-vehicle device.

13

14   According to a fifth aspect of the invention there

15   is provided a route guidance system comprising an

16   in-vehicle device and a central route advisory

17   system in which the in-vehicle device comprises

18   units adapted to provide instructions to a user to

19   perform manoeuvres required to complete an optimal

20   route, wherein the optimal route is calculated by

21   the central route advisory system taking into

22   account the previous travelling direction of the

23   vehicle, in response to a route request from the

24   user to a human operator in the central route

25   advisory system to a specified destination, and the

26   optimal route is transmitted by the central route

27   advisory system to the in-vehicle device.

28

29   According to a sixth aspect of the invention there

30   is provided a route guidance method comprising the

31   steps of:

7

1   (a)   receiving a call from a user's in-vehicle
2   device indicating the user's desired
3   destination;
4   (b)   entering the user's desired destination into a
5   route-guidance system;
6   (c)   determining the current location of the user's
7   vehicle;
8   (d)   determining the potential routes to the desired
9   destination;
10 (e)   ascertaining traffic conditions along the
11   potential routes;
12 (f)   determining the optimal route to the desired
13   destination using the distances of the
14   potential routes and the traffic conditions
15   along the routes;
16 (g)   establishing route key-points along the optimal
17   route;
18 (h)   associating flags with the route key-points;
19 (i)   transmitting the route key-points and flags to
20   the user's in-vehicle device; and
21 (j)   providing visual and audio instructions to the
22   user as the user's vehicle approaches the route
23   key-points along the optimal route.
24
25 According to a seventh aspect of the invention there
26 is provided a route guidance method comprising the
27 steps of:
28 (a)   receiving a call from a user's in-vehicle
29   device indicating the user's desired
30   destination;
31 (b)   determining the current location of the user's
32   vehicle;

1   (c)   entering the user's desired destination into a
2   route-guidance system;
3   (d)   determining the potential routes to the desired
4   destination;
5   (e)   ascertaining traffic conditions along the
6   potential routes;
7   (f)   determining the optimal route to the desired
8   destination using the distances of the
9   potential routes and the traffic conditions
10   along the routes;
11   (g)   establishing route key-points along the optimal
12   route;
13   (h)   associating flags with the route key-points;
14   (i)   transmitting the route key-points and flags to
15   the user's in-vehicle device; and
16   (j)   providing instructions to the user as the
17   user's vehicle approaches the route key-points
18   along the optimal route.
19
20   According to an eighth aspect of the invention there
21   is provided a route guidance method comprising the
22   steps of:
23   (a)   receiving a call from a user's in-vehicle
24   device indicating the user's desired
25   destination;
26   (b)   entering the user's desired destination into a
27   route-guidance system;
28   (c)   determining the current location of the user's
29   vehicle from a dual multi-frequency tone
30   transmission from the user's in-vehicle device;
31   (d)   determining the potential routes to the desired
32   destination;

1 (e) ascertaining traffic conditions along the
2   potential routes;
3 (f) determining the optimal route to the desired
4   destination using the distances of the
5   potential routes and the traffic conditions
6   along the routes;
7 (g) establishing route key-points along the optimal
8   route;
9 (h) associating flags with the route key-points;
10 (i) transmitting the route key-points and flags to
11   the user's in-vehicle device; and
12 (j) providing instructions to the user as the
13   user's vehicle approaches the route key-points
14   along the optimal route
15
16 Alternatively, the current position of the user's
17 vehicle is determined from an ISDN sub-addressing
18 transmission from the user's in-vehicle device.
19
20 According to a ninth aspect of the invention there
21 is provided a route guidance method comprising the
22 steps of:
23 (a) receiving a call from a user's in-vehicle
24   device indicating the user's desired
25   destination;
26 (b) entering the user's desired destination into a
27   route-guidance system;
28 (c) determining the current location of the user's
29   vehicle;
30 (d) determining the potential routes to the desired
31   destination;

1   (e)   ascertaining traffic conditions along the
2   potential routes;
3   (f)   determining the optimal route to the desired
4   destination using the distances of the
5   potential routes and the traffic conditions
6   along the routes;
7   (g)   establishing route key-points along the optimal
8   route;
9   (h)   associating flags with the route key-points;
10   (i)   transmitting the route key-points and flags to
11   the user's in-vehicle device;
12   (j)   using route convergence model to determine the
13   direction in which the user's vehicle is
14   travelling once the vehicle commences the
15   journey along the optimal route;
16   (k)   providing visual and audio instructions to the
17   user as the user's vehicle approaches the route
18   key-points along the optimal route.
19

20 Preferably, the in-vehicle device uses the route
21 convergence model to display the current route on
22 which the vehicle is travelling.
23

24 Advantages of the Invention
25

26 Audible instructions of the type described in EP
27 1262936 can sometimes be ambiguous or misleading.
28 To overcome this problem, the present invention
29 includes display devices to provide visual aids to
30 supplement the audio instructions provided by the
31 in-vehicle device. These display devices also
32 provide the user with additional information such as

1   a distance count-down to a junction, estimated time
2   of arrival at a destination, proximity of speed
3   cameras etc.
4
5   A first embodiment of the invention includes a
6   monochrome display unit which displays junctions,
7   roundabouts etc. in simple pictographic format. The
8   second embodiment of the invention includes a colour
9   display unit which displays road-maps and depicts
10 the present location of the vehicle on the map. The
11 colour display unit also provides a user interface
12 which enables the user to make and receive voice
13 calls (other than to the call central route advisory
14 system) and to receive text messages.
15
16 The display units also provide user interfaces to
17 the route guidance system and enable a user to make
18 automatic route requests based on the post-code of a
19 destination, or previously stored favourite
20 destinations or previously visited destinations.
21
22 The first and second embodiments of the present
23 invention also includes a mechanism of encoding
24 pictograms representing junctions roundabouts etc.
25 in a data efficient manner so that the resulting
26 data can be readily transmitted to the user's in-
27 vehicle device.
28
29 The fifth embodiment of the present invention
30 employs a novel SMS messaging sequence to the call
31 centre advisory system.
32

12

1   EP 1262936 used SMS messaging to transmit the
2   vehicle's current GPS position to the central route
3   advisory system. Since SMS messaging may be
4   expensive, the sixth and seventh embodiments of the
5   present invention employ a less expensive dual-tone-
6   multi-frequency (DTMF) system and/or ISDN sub-
7   addressing mechanism for transmitting the vehicle's
8   current location to the central route advisory
9   system.

10

11   EP 1262936 described a route guidance system which
12   combined map information and historical and real-
13   time traffic information to determine the optimal
14   route to a required destination. However, the route
15   guidance system described in EP 1262936 relied
16   entirely on information acquired at the time at
17   which the route request was made. The system
18   described in EP 1262936 did not take into account
19   the fact that traffic conditions are dynamically
20   variable, so that the traffic conditions prevailing
21   at a particular point in time might not be
22   applicable an hour later. The fourth embodiment of
23   the present invention employs a time dependent
24   forecasting model to predict future traffic
25   conditions and in particular to predict the traffic
26   conditions that a driver might expect to encounter
27   on entering a particular route segment. The
28   forecast estimate is determined from the time at
29   which the route request is received by the central
30   route advisory system. The use of the time
31   dependent traffic forecasting model enables the

1   route guidance system to more accurately reflect the

2   dynamic nature of traffic flow.

3

4   Nine embodiments of the invention will now be

5   described with reference to the accompanying

6   drawings in which

7   Figure 1 is a block diagram of the in-vehicle

8   device showing the colour and monochrome display

9   units of the first and second embodiments of the

10 route guidance system;

11   Figure 2 is a block diagram of the hardware

12 components of the central call centre advisory

13 system of the routing guidance system;

14   Figure 3 is a schematic representation of an

15 example scenario demonstrating the function of a

16 confirmation point triplet;

17   Figure 4 is a schematic representation of an

18 example scenario demonstrating the function of

19 benign confirmation points;

20   Figure 5a is a pictogram of a roundabout as

21 would be displayed by the monochrome and colour

22 display units;

23   Figure 5b is a pictogram of a junction as would

24 be displayed by the monochrome and colour display

25 units;

26   Figure 6 is screen shot of the normal display

27 mode of the monochrome display units;

28   Figure 7 is a pictogram of bent variants of the

29 straight ahead arrow denoting bends on the route

30 ahead, as would be displayed by the monochrome and

31 colour display units;

14

1   Figure 8 is a series of pictograms of compound

2   junctions that would be displayed by the monochrome

3   and colour display units; and

4   Figure 9 is a screen shot of the compass aid

5   screen of the monochrome display unit.

6

7   The following description will first discuss the

8   hardware architecture of the route guidance system.

9   The role and function of route key-points in the

10   route guidance system will then be described

11   followed by a discussion of the route convergence

12   model and the smart start system. The description

13   will finally discuss the software architecture

14   employed in the first and second embodiments of the

15   invention which include the monochrome and colour

16   display units respectively.

17

18   HARDWARE ARCHITECTURE OF THE ROUTE GUIDANCE SYSTEM

19

20   As described in EP 1262936, the route guidance

21   system comprises in-vehicle devices and a central

22   route advisory system. An in-vehicle device is

23   installed in each user's vehicle and communicates

24   with the central route advisory system through a

25   mobile telephone network. An overview of the

26   architectures of the in-vehicle devices and the

27   central route advisory system will be discussed in

28   turn below.

29

30   Referring to Figure 1 and the first embodiment of

31   the route guidance system, an in-vehicle device 10

32   comprises a navigation unit 12 which in turn

1   comprises a GPS (Global Positioning System) receiver

2   14, a mobile telephone device 16 and a memory 19 for

3   the mobile telephone device 16. The navigation unit

4   12 further comprises a speech synthesiser 18, a

5   control microprocessor 22 and an on-board memory 20

6   for the speech synthesiser 18. The memory 20 for

7   the speech synthesiser 18 stores a variety of words

8   and phrases which acts as a vocabulary for the in-

9   vehicle device. The navigation unit 12 finally

10 comprises a memory for storing previous destinations

11 visited by the user 23. The speech synthesisor is

12 coupled to any suitable form of audio emitter, for

13 example, an amplifier and speaker or an existing in-

14 vehicle audio system.

15

16 The in-vehicle device 10 further comprises a

17 monochrome video display unit 24 and its own on-

18 board memory 25. The memory 25 for the monochrome

19 display unit 24 stores the latitude and longitude

20 details of user-defined destinations.

21

22 The monochrome display unit 24 is a 128x64 pixel

23 FSTN LCD, although it will be appreciated that other

24 monochrome display devices could also be used. The

25 monochrome display unit includes a touch-screen

26 comprising eight fixed touch areas. The monochrome

27 display is back-lit with a blue LED edge light which

28 can be dimmed at night for safe viewing at night.

29 The contrast of the monochrome display is

30 automatically adjusted in response to changes in

31 ambient temperature. The monochrome display is

32 connected to the in-vehicle device by a bi-

1   directional RS232 interface and in use is further

2   connected to an ignition switched vehicle power

3   supply.

4

5   In the second embodiment of the route guidance

6   system, the monochrome display unit 24 and its

7   memory 25 is replaced with a colour display unit 26

8   and its memory 27. The colour display unit is 5.7

9   inch diagonal colour QVGA (320x240 pixel) STN LCD

10   incorporating a touch screen, although it will be

11   appreciated that other colour displaying devices

12   could also be used. The monochrome display unit

13   memory 25 and colour display unit memory 27 both

14   also store graphic elements used to construct

15   pictograms in accordance with encoded instructions

16   from the central route advisory system.

17

18   The monochrome display unit memory 25 and colour

19   display unit memory 27 both also store graphic

20   elements used to construct pictograms in accordance

21   with encoded instructions from the central route

22   advisory system.

23

24   Referring to Figure 2, the central route advisory

25   system 30 comprises a navigation server 32, an

26   extraction server 33 and a traffic server 34. The

27   navigation server 32 calculates an optimal route to

28   a destination on receipt of a user request. The

29   optimal route is determined using data from the

30   traffic server 34. The navigation server 32 then

31   transmits details of the optimal route to the

32   extraction server 33 which formats the data for

1   transmission to the user's in-vehicle device as a

2   compressed data message.

3

4   Looking at the relationship between the navigation

5   server 32 and the extraction server 33 in more

6   detail, the navigation server 32 typically expresses

7   a calculated optimal route in NavML (or other

8   suitable route engine output). The extraction

9   server 33 then extracts the relevant information

10   from the NavML (or other suitable route engine

11   output) stream to construct a route_summary message

12   and encodes it for wireless transmission to the

13   user's in-vehicle device.

14

15   Route_summary messages typically include a set of

16   GPS positions of route key-points along the optimal

17   route. In general a number of the route key-points

18   are included in any optimal route spaced at

19   intervals of approximately 1 mile. In particular,

20   route key-points are included at positions along the

21   route where an instruction must be given to the

22   driver, or at positions where it might be possible

23   for a driver to make a wrong-turning or take the

24   wrong exit from a roundabout etc. and thereby

25   deviate from the optimal route.

26

27   As part of the audio-prompting mechanism of the

28   route guidance system, Route_summary messages

29   typically also include a number of flags or tokens

30   which are associated with individual route key-

31   points. The flags are used for selecting individual

32   words or phrases from the in-vehicle device's on-

1 board memory and playing the words or phrases to the
2 driver. The flags trigger the selection and playing
3 of a word or phrase as the vehicle passes an
4 associated route key-point. Consequently complete
5 sentences can be constructed as the vehicle passes
6 successive route key-points.
7
8 A description of the role and function of route key-
9 points will follow the description of the hardware
10 architecture of the route guidance system.
11
12 In the first and second embodiments of the route
13 guidance system, a route-message typically uses
14 information extracted from the NavML (or other
15 suitable route engine output) stream to encode
16 pictograms representing junctions and roundabouts on
17 the calculated optimal route.
18
19 For example, if the optimal route includes a
20 roundabout, details of the roundabout including its
21 structure, required entrance and exit are
22 transmitted in NavML form (or other suitable route
23 engine output) by the navigation server 32. The
24 extraction server 33 extracts the relevant
25 information from the NavML (or other suitable route
26 engine output) stream and encodes it for
27 transmission to the in-vehicle device. The encoding
28 process involves representing the roundabout with a
29 specific binary code recognised by the in-vehicle
30 device.
31

1   As indicated above, the monochrome and colour

2   display unit memory chips 25 and 27 store specific

3   graphic elements for constructing pictograms. In

4   the case of the roundabout example, on receipt of

5   the roundabout identifier from the extraction server

6   33, the display unit memory chips 25 and 27 retrieve

7   the circular graphic component used for representing

8   roundabouts.

9

10   The roundabout graphic element has twelve slots

11   about its circumference. On receipt of a code

12   identifying the required entrance to the roundabout,

13   a linear graphic element is inserted in the circular

14   graphic element at slot zero. Using a clock as an

15   analogy for the circular graphic element, slot zero

16   is located at the six o'clock position. This leaves

17   eleven remaining slots for depicting the potential

18   exits from the roundabout. Linear graphic elements

19   are retrieved from the monochrome and colour display

20   unit memory chips 25 and 27 and positioned in slots

21   around the circular graphic element moving in a

22   generally clockwise direction according to the

23   specific binary instructions transmitted by the

24   extraction server 33. A further code is transmitted

25   by the extraction server 33 to specifically identify

26   the required exit from the roundabout. A similar

27   process is used for encoding and depicting radial

28   junctions.

29

30   Route_messages also typically include textual

31   entries for the names of the required entry and exit

32   roads from any junctions on the optimal route.

1   In terms of the architecture of the central route

2   advisory system 30, the navigation server 32

3   communicates with a traffic repository 36 which

4   stores historical traffic information and road

5   closures data. Historical data is data which has

6   been compiled over a period of time to reflect

7   changes in traffic patterns that occur depending

8   upon the time of day or the day of the month in

9   question (e.g. rush hour traffic varying by day of

10   week and season).

11

12   The navigation server 32 also communicates with an

13   application programming interface (API) 40. The API

14   40 facilitates communication between the navigation

15   server 32 and a map database 42 via requests and

16   responses. The map database 42 contains map data

17   together with real time traffic information and

18   historical traffic information. In effect, the

19   navigation server 32 calculates an optimal route for

20   a user, taking into account the distances to be

21   travelled along different routes and traffic

22   conditions along the routes. Traffic conditions are

23   used to estimate the speed at which a vehicle might

24   be expected to travel along a candidate route and

25   thus the delay that a driver might experience along

26   that route. The inclusion of traffic condition

27   information into the algorithm for determining the

28   user's optimal route is known as "traffic impacted

29   routing".

30

31   In a fourth embodiment of the route guidance system,

32   the route optimisation calculations performed by the

1   navigation server are further enhanced by the use of

2   a time dependent traffic forecasting model. The

3   traffic forecasting model forecasts the traffic

4   conditions that might be expected along a route

5   segment depending upon the time at which a route

6   request was received (T_{req} 44). The forecasting

7   model is designed to be time dependent, so that it

8   can more accurately reflect the dynamic and time-

9   varying nature of traffic congestion.

10

11   Using the time dependent traffic forecasting model,

12   the navigation server adjusts the speeds at which

13   the user might be expected to travel along candidate

14   route segments according to the traffic conditions

15   that might be expected to exist along these route

16   segments. As mentioned above the traffic conditions

17   are forecasted based on the time at which a route

18   request is received (T_{req} 44).

19

20   As a simple example, consider a journey at 5 p.m.

21   for which there are two potential routes to the

22   required destination (i.e. $Route_A$ and $Route_B$).

23   Suppose $Route_B$ is longer than $Route_A$. However, let

24   us also suppose that during rush-hour (i.e. 5 p.m.)

25   $Route_A$ is considerably busier than $Route_B$. In this

26   circumstance a driver might be expected to travel

27   more slowly on $Route_A$ than they might on $Route_B$.

28   Consequently, whilst $Route_B$ might be longer than

29   $Route_A$ the driver might nonetheless have a journey of

30   shorter duration taking $Route_B$ rather than $Route_A$.

31

22

1   Looking at the time dependent traffic forecasting
2   model in more detail, the model generates a forecast
3   from data contained in an averaged historical
4   traffic archive together with a forward calendar.
5   The records contained in the averaged historical
6   traffic archive represent average traffic conditions
7   measured over an extended period (e.g. showing
8   differences between week-day and weekend traffic
9   conditions along a particular route segment). The
10 forward calendar is used by the forecast model to
11 select a record from the historical traffic archive
12 that is most relevant to the date at which the route
13 request is made. The forward calendar can also be
14 used as part of a long-term forecasting system if a
15 route request is made in respect of a future date.
16 A short-term forecast of the expected traffic
17 conditions along a candidate route segment is made
18 by the forecasting model using the selected
19 historical traffic record together with the time at
20 which the route request is made (T_{req} 44) and the
21 real-time current traffic conditions recorded at the
22 time the route request was made.
23
24 In a third embodiment of the invention, the
25 navigation server 32 also communicates with a
26 typical traffic information (TTI) database 38. TTI
27 refers to traffic information relating to un-
28 monitored routes e.g. non-trunk A roads, minor roads
29 and urban streets. The TTI database 38 contains a
30 static data-set that can be used by the navigation
31 server 32 to calculate optimal routes for any time
32 of any day.

1   The data contained in the TTI database 38 are

2   equivalent to the data provided for the monitored

3   roads by the long-term forecast. As there is no

4   real-time data for these roads this data is not

5   updated in real-time to produce a more accurate

6   short-term forecast for these route segments.

7   However, the TTI data can be over-ridden on the

8   occurrence of specific traffic events.

9

10   Without the use of the time-dependent traffic

11   forecasting model, the navigation server 32 can only

12   base its route calculations on the conditions of the

13   route at the time of calculating the route.

14   Clearly, such route calculations do not consider the

15   changes in the traffic conditions on a given route

16   segment that might have occurred between the time of

17   the original route calculations and the time at

18   which the driver reaches the route segment in

19   question.

20

21   In addition to providing route information, the

22   central route advisory system 30 can provide a user

23   with traffic congestion information. Traffic

24   congestion information is acquired by the traffic

25   server from a variety of sources such as roadside

26   speed cameras and traffic reports.

27

28   The traffic server 34 communicates real time traffic

29   information and historical traffic information to

30   the navigation server 32 and additionally transmits

31   historical traffic information to a historical

32   traffic information database 46.

1　The historical traffic information database 46

2　provides a map compiler 48 with historical traffic

3　information. The map compiler 48 formats map data

4　together with real time traffic information and

5　historical traffic information and the standard

6　speed for a given road link. The map compiler 48

7　transmits this information to the map database 42

8　which in effect contains standard default expected

9　speeds (impedances) along road-links.

10

11　The traffic server 32 also communicates with a users

12　database 50. The users database 50 stores user

13　profile data (e.g. user's name & address etc.).

14　This data can be amended in accordance with user's

15　requirements (e.g. by the user through an internet

16　connection or by customer services representatives).

17

18　Taking a more detailed look at the relationship

19　between the in-vehicle device 10 and the central

20　route advisory system 30, in use, a user may use the

21　in-vehicle device 10 to manually contact a call

22　centre operator at the central route advisory system

23　30 and provide his required destination. The

24　operator then supplies the required destination to

25　the navigation server 32.

26

27　The system employs two different approaches to

28　transmitting the vehicle's current position. In the

29　first approach whilst the user is speaking to the

30　call-centre operator, the in-vehicle device's

31　navigation unit transmits its calling line identity

32　(CLI) and the current GPS position of the vehicle in

25

1   an SMS message to the navigation server 32. The

2. advantage of transmitting the navigation unit's CLI

3   before the voice-call is established is that the SMS

4   message containing the CLI has more time to reach

5   the navigation server 32. However, the disadvantage

6   of this approach is that there is a delay in the

7   establishment of the voice-call. In a fifth

8   embodiment of the route guidance system, a second

9   approach is employed in which the navigation unit

10 transmits the SMS message to the navigation server

11 32 before the voice-call is set up between the

12 driver and the call-centre operator. The advantage

13 of this approach is that there is less delay in

14 establishing a voice-call to a call-centre operator.

15 However, more of the duration of the voice-call is

16 taken up with transmitting the CLI to the navigation

17 server than with the first approach.

18

19 On receipt of the route request, the navigation

20 server 32 calculates the optimal route to the

21 required destination, taking into account the user's

22 preferences and traffic conditions, particularly

23 traffic congestion. As discussed above, the

24 navigation server 32 may also use a time-dependent

25 traffic forecasting model to determine the optimal

26 route for the user.

27

28 The navigation server 32 then transmits a response

29 to the optimal route query in a NavML (or other

30 suitable route engine output) stream to the

31 extraction server 33. The extraction server 33

32 extracts the relevant information from the NavML (or

1   other suitable route engine output) stream and

2   encodes into a compressed data message suitable for

3   wireless transmission to the in-vehicle navigation

4   unit. The compressed data message includes all the

5   route key-points on the optimal route together with

6   flags at associated route key-points for triggering

7   audible manoeuvre prompts to the user. In the case

8   of the first and second embodiments of the route

9   guidance system, the compressed data message also

10   includes encoded pictograms and textual information.

11

12   The communications channel between the in-vehicle

13   device and the central route advisory system 30 is

14   then closed and the extraction server 33 does not

15   communicate any further with the in-vehicle device

16   unless the driver requests a different route to the

17   same or a different destination or traffic

18   conditions have changed since the original route

19   request.

20

21   As described above, as the vehicle progresses along

22   the optimal route and passes individual route key-

23   points a flag may be activated triggering the

24   selection of a word or phrase from the in-vehicle

25   device's on-board memory. The word or phrase is

26   then played to the driver through the speech

27   synthesiser to provide audible prompts of required

28   manoeuvres, oncoming junctions etc.

29

30   In the first and second embodiments of the route

31   guidance system, as the vehicle progresses along the

32   optimal route and passes individual route key-

1   points, pictograms displaying nearby junctions or

2   roundabouts are displayed on the in-vehicle device's

3   monochrome or colour display units, together with

4   visual indications of the required manoeuvre and the

5   names/numbers of the entry and exit routes from the

6   junction or roundabout in question. Further

7   discussions of the manner in which junctions and

8   roundabouts are displayed will follow in the

9   discussion of the software architectures of the

10   monochrome and colour display units.

11

12   Returning to the manner in which the in-vehicle

13   device transmits a route request to the central

14   route advisory system 30, since SMS messaging may be

15   costly, the in-vehicle navigation unit may use two

16   less costly, alternative means of transmitting the

17   current GPS position of the vehicle. In the sixth

18   embodiment of the route guidance system, the

19   navigation unit transmits the GPS position of the

20   vehicle to the navigation server 32 using dual-tone-

21   multi-frequency (DTMF) tones at the start of the

22   user's voice-call to the central route advisory

23   system 30.

24

25   In the seventh embodiment of the route guidance

26   system, the in-vehicle navigation unit transmits the

27   vehicle's current GPS position to the navigation

28   server 32 using ISDN sub-addressing as the voice-

29   call to the central route advisory system 30 is

30   being set up. ISDN sub-addressing may be used for

31   this purpose because the ISDN specification allows

32   for additional characters to be appended to a called

1   telephone number. These characters are usually used

2   for further call routing once a call is connected.

3   However, the number of extra characters that may be

4   appended to a called telephone number is also

5   sufficient to enable the transmission of an encoded

6   geographic location.

7

8   All of the above methods of transmitting a route

9   request to the central route advisory system 30 have

10   relied upon a manual process of establishing a

11   voice-call to the call-centre advisory system and

12   telling the call-centre operator the required

13   destination, whereupon the operator manually enters

14   the required destination into the navigation server

15   32.

16

17   In addition to the above manual voice-call based

18   route request process, the route guidance system can

19   also support a process for automatically making a

20   route request. In particular, the user can use the

21   in-vehicle navigation unit to automatically send a

22   route request to a specified or desired destination

23   to the central call centre advisory system

24   navigation server by using the favourites function

25   or previous destination function.

26

27   ROLE AND FUNCTION OF ROUTE KEY-POINTS

28

29   Route key-points can be classified as preparation

30   points, warning points, instructions points,

31   manoeuvre points and confirmation points. A

32   preparation point is positioned along a selected

1   route before a location where a manoeuvre must be

2   performed by the user to reach the required

3   destination. The purpose of the preparation point

4   is to provide a warning to a driver to prepare to

5   perform the required manoeuvre. A typical audio

6   prompt for a preparation point would be "prepare to

7   turn left in 6 yards".

8   A warning point is positioned closer to the location

9   of the required manoeuvre than a preparation point.

10   A warning point similarly serves to warn the driver

11   that he will be required to perform a manoeuvre

12   soon. However, it should be noted that in the case

13   where a driver might be required to perform a series

14   of manoeuvres within a short distance of each other

15   it might not be possible to place a preparation

16   point and warning point before each manoeuvre.

17

18   An instruction point is placed very close to the

19   location where the required manoeuvre must be

20   performed. A typical audio prompt for an

21   instruction point would be "Please turn left".

22

23   A manoeuvre point is a point along the prescribed

24   route where a manoeuvre must be performed by the

25   driver. These points are used internally by the

26   route guidance system and no instructions are given

27   to the driver as they pass these points.

28

29   There are two forms of confirmation points, spoken

30   and non-spoken. A spoken confirmation point

31   provides audible confirmation to the driver that

32   they have completed a required manoeuvre correctly.

A typical spoken confirmation point prompt might be
"continue driving for 5 yards".

A non-spoken confirmation point does not provide an
audible prompt to the driver, but instead is used by
the route guidance system to ensure that the vehicle
is being driven along and has not deviated from the
prescribed optimal route.

Looking firstly at spoken confirmation points, take
for example, the situation shown in Figure 3. In
this example a car 50 is travelling along a main
road 52 from which there are a number of side-roads
54a, 54b and 54c. The prescribed optimal route
requires the driver of the car 50 to continue along
the main road 52. Thus if the driver drives the car
50 onto one of the side roads 54a, 54b or 54c, the
car will no longer be following the prescribed
optimal route and can be said to be "off-route".

In order to determine whether or not a car has been
driven "off-route" (onto one of the side roads), a
set of three confirmation points (known as a CP
triplet) is positioned around each of the junctions
with the side-roads. The CP triplet is designed so
that a first confirmation point CP_1 is situated
before each junction and the two remaining
confirmation points CP_2 and CP_3 are positioned after
each junction with CP_2 being positioned closer to
the junction than CP_3.

1   CP_1 is known as a pre-junction confirmation point

2   and CP_2 and CP_3 are collectively known as post-

3   junction confirmation points. Two post-confirmation

4   points are used in the CP triplet to introduce

5   redundancy into the "off-route" detection system to

6   cope with mapping and GPS errors in the system. For

7   the example shown in Figure 3, the CP triplet

8   associated with each side road 54a, 54b and 54c are

9   designated with a, b and c superscripts

10   respectively.

11

12   Returning to the example shown in Figure 3, as

13   mentioned previously the car 50 is being driven

14   along main road 52 and is approaching the side road

15   54b. If the car 50 passes CP_1^b and CP_2^b or CP_3^b, it

16   is clear that the vehicle is correctly following the

17   optimal route and has not been driven down the side

18   road 54b. However, if the car 50 passes CP_1^b, but

19   does not pass CP_2^b or CP_3^b, it is clear that the car

20   50 has been driven onto side road 54b and is thus

21   "off-route". In this circumstance, the in-vehicle

22   device issues a prompt to the driver warning him

23   that he has driven off the prescribed optimal route.

24

25   Having so far described the role of spoken

26   confirmation points in CP triplets, the description

27   will now turn to the role of non-spoken confirmation

28   points.

29

30   Consider, for example, the situation shown in Figure

31   4 in which a car 60 is parked by the side of a road

32   62. The road ends in a T-junction 64 and the

1   prescribed optimal route requires the driver to turn

2   left onto the T-junction 64. Under normal

3   circumstances a preparation point, warning point and

4   instruction point would have been positioned before

5   the T-junction, to warn the driver that he is

6   approaching the junction and advising the driver of

7   which direction to turn at the junction. However,

8   given the limits to the resolution of domestically

9   available GPS, it is conceivable that the car 60

10   might have been parked at a position 66 between the

11   instruction point for the T-junction 64 and the

12   manoeuvre point representing the T-junction 64

13   itself. In this case, the driver would not receive

14   an instruction as to which direction to turn at the

15   T-junction 64. To overcome this problem, multiple

16   confirmation points CP_1 to CP_n are spaced at close

17   intervals along the road 62. The route message

18   summary transmitted to the in-vehicle device from

19   the central route advisory centre includes a flag

20   for each of the confirmation points indicating that

21   the driver should be advised to "turn left at the

22   junction". Consequently, even though the car might

23   miss the preparation, warning and instruction points

24   for the junction, the driver will nonetheless

25   receive instructions as to which direction to turn

26   on the junction.

27

28   However, since there may be several confirmation

29   points located between the original parking position

30   66 of the car 60 and the T-junction 64, it would be

31   undesirable to have the same "turn left at the

32   junction" message repeatedly played to the driver as

1   the car 60 passes each of these confirmation points.

2   To overcome this problem, as the car 60 passes the

3   first confirmation point after the parking position

4   66, the driver is prompted to "turn left at the

5   junction" and the remaining confirmation points on

6   the road 62 are converted into non-spoken

7   confirmation points, so that the prompt is not sent

8   to the driver again as the car 60 passes the

9   remaining confirmation points to the T-junction 64.

10   Such non-spoken confirmation points are also known

11   as "benign" confirmation points. An exception to

12   this procedure exists if the vehicle is required to

13   drive across a main road to reach the T-junction. In

14   this case a warning is issued to the user as he

15   approaches the main road.

16

17   THE SMART START SYSTEM AND BRANCH CONVERGENCE MODEL
18

19   As discussed above, any route from a first location

20   to a second location is characterised by the route

21   guidance system by a number of route key-points

22   which include locations at which specific manoeuvres

23   must be performed by the driver (e.g. turn right at

24   the T-junction etc.) or locations at which the

25   progress of a vehicle can be checked to determine

26   whether the vehicle is still on the correct route.

27

28   In general, from any particular starting point there

29   may be many different alternative routes or

30   "branches" to the required destination. As the

31   journey progresses the number of alternative routes

32   to the destination steadily decrease, until all the

1   alternative routes eventually converge into a single

2   "onward route" to the destination. Since each

3   alternative route is characterised by a set of route

4   key-points, the start of any journey is similarly

5   characterised by the presence of a number of

6   different sets of route key-points, one for each

7   alternative route to the destination. As the

8   journey progresses, the process of route convergence

9   is reflected in a steady decrease in the number of

10   sets of route key-points which can be used to

11   describe the journey.

12

13   Consider for example, a car parked on a street. The

14   car may be pointed in one of two directions on the

15   street and thus there are two directions in which

16   the car may progress down the street from its

17   parking position (and thus two potential branches

18   from the starting position). If the car passes a

19   route key-point situated at either end of the street

20   it is possible to determine in which direction the

21   car is travelling and thus the branch corresponding

22   to the direction in which the car did not travel

23   disappears.

24

25   SOFTWARE ARCHITECTURE OF THE FIRST AND SECOND

26   EMBODIMENTS OF THE ROUTE GUIDANCE SYSTEM

27

28   (A)   MONOCHROME DISPLAY UNIT SOFTWARE

29

30   The main purpose of the monochrome display unit is

31   to provide user guidance to a user to supplement the

1   audible instructions issued by the in-vehicle

2   device.

3

4   The monochrome display unit has a number of

5   different display modes including a normal display,

6   a compass display, a menu display and a guidance

7   inactive display. These display modes will be

8   described in more detail below.

9   **(1) Normal Display Mode**

10

11   The information displayed by the monochrome display

12   unit consists primarily of graphical icons

13   representing junctions and roundabouts etc. as seen

14   in Figures 5a and 5b. The purpose of such displays

15   is to clarify ambiguous audible instructions issued

16   by the in-vehicle device.

17

18   The normal screen displayed by the monochrome

19   display unit is shown in Figure 6 and comprises four

20   main sections, namely a target/current road section

21   100, a junction pictogram/straight ahead arrow

22   section 102, a distance countdown section 104 and an

23   information zone section 106. These sections will

24   be described in more detail below.

25

26   (i) Target/Current Road Section 100

27   This section shows the number and/or name of the

28   road that the vehicle is currently on and the number

29   and/or name of the road onto which the vehicle

30   should turn during a manoeuvre. When driving

31   straight ahead the current road will be shown.

32

1   (ii) Junction Pictogram/Straight Ahead Arrow Section

2   102

3

4   This section displays a pictogram depicting a

5   roundabout or radial junction such as those shown in

6   Figures 5a and 5b. The display is initiated when

7   the vehicle passes a preparation point and continues

8   to be displayed during the subsequent manoeuvre.

9   When driving straight ahead, an arrow symbol is used

10   instead of the roundabout/radial junction pictogram.

11   The arrow symbol can be displayed in a variety of

12   curved forms as shown in Figure 7 to reflect changes

13   in road direction.

14

15   Both the radial and roundabout pictograms comprise a

16   central point from which 12 branches are disposed at

17   30° degrees angle relative to each other. The

18   required route through the roundabout or radial

19   junction is highlighted on the pictogram.

20

21   The monochrome display unit also displays pictograms

22   depicting compound junctions, such as those seen in

23   Figure 8. These pictograms essentially comprise

24   assemblies of the roundabout and radial junction

25   pictograms previously discussed.

26

27   If the navigation unit of the in-vehicle device

28   detects that the vehicle has passed an appropriate

29   confirmation point, it is clear that the driver has

30   correctly completed the required manoeuvre and the

31   junction pictogram is replaced by the straight ahead

32   pictogram.

1 (iii) Distance Countdown Section 104

2 This section provides a graphical and/or numeric

3 representation of the remaining distance until a

4 manoeuvre is to be executed (the "manoeuvre point").

5

6 (iv) Information Zone 106

7 This section is used to display the estimated

8 time of arrival (ETA) and distance to the required

9 destination This section can also be used to

10 display warnings to the driver of oncoming speed

11 cameras and to indicate the speed limit in the

12 vicinity of a speed camera.

13

14 <u>**(2)   Compass Display Mode**</u>

15

16 At the start of a journey, or in the event that a

17 vehicle deviates from the prescribed optimal route.

18 The normal display (described above) is changed to a

19 "compass" type display as shown in Figure 9

20 comprising an arrow shaped indicator (the compass

21 arrow) of the direction of travel.

22

23 If the vehicle is starting a journey, the compass

24 arrow points towards the first route key-point on

25 the prescribed optimal route and the display

26 provides an indication of the distance to this point

27 and its associated road name.

28

29 As described in an earlier example, in the case of a

30 car starting a journey from a position parked by the

31 side of a road, it is not possible to determine the

32 direction in which the car is pointed and thus,

1   until the vehicle has moved it is not possible to

2   determine the direction in which it is travelling.

3   In this circumstance, the most recent travel

4   direction of the car prior to the present journey is

5   stored by the in-vehicle device and used to

6   calculate the direction in which the compass arrow

7   on the monochrome display should point.

8   In the case where a vehicle has deviated from a

9   prescribed optimal route, the compass arrow points

10   towards the final destination point and an "off

11   route" warning is displayed instead of the road-name

12   of the next route key-point on the prescribed

13   optimal route.

14

15   **(3)   Menu Display Mode**

16

17   The touch screen of the monochrome display unit acts

18   as a user interface to the in-vehicle device.

19   Touching the screen activates a menu of functions

20   including:

21   (i)   Call centre

22   (ii)   Advanced guidance

23   (iii)   Mute

24   (iv)   Repeat

25   (v)   SOS

26

27   <u>(i) Call Centre</u>

28   Activating the call centre function initiates a

29   manual route-request to the call centre advisory

30   system.

31

32

1 (ii) Advanced Guidance

2 The advanced guidance menu option provides access to

3 a sub-menu containing additional guidance-related

4 options including:

5   (a)   Presets 1 to 9

6   (b)   Re-route

7   (c)   Cancel

8   (d)   Suspend/Resume

9 These options will be discussed in more detail

10 below.

11

12   *(a)*   *Presets 1 to 9*

13 This option allows the selection of destinations

14 that have been preset via a web site.

15 Selecting a destination, causes the in-vehicle

16 device to send an automated request to the call

17 centre advisory system for a route to the

18 destination.

19

20   *(b)*   *Re-route*

21 The re-route option allows a user to invoke a

22 routing call to determine a new route to the

23 currently selected destination. If guidance to the

24 destination is not already in progress, the re-route

25 option is inactivated.

26

27   *(c)*   *Cancel*

28 This option enables a user to abandon route

29 guidance.

30

31

32

1   *(d)   Suspend/Resume*

2   Selecting the suspend option causes the in-vehicle

3   device to mute guidance and traffic related audible

4   instructions and suppress pictograms and re-routing

5   advice. In the meantime, the in-vehicle device

6   continues to scan and match route key-points along

7   the prescribed optimal route.

8

9   (iii) Mute

10   This option silences any audible prompt that is

11   being issued by the in-vehicle device.

12

13   (iv) Repeat

14   This option repeats the last audible prompt issued

15   by the in-vehicle device.

16

17   (v)   SOS

18   The SOS option allows a user to make a voice call to

19   a preset emergency and/or breakdown telephone

20   number.

21

22   **(4)   Inactive Guidance Display Mode**

23   When the user has not requested route guidance (i.e.

24   guidance is inactive), the monochrome display

25   provides general information to the user. The

26   information displayed by the monochrome display unit

27   in such circumstances includes

28   (a)   the current time

29   (b)   speed camera warnings

30   (c)   a graphical compass depicting the current

31   direction of travel.

32

1   **(B)   COLOUR DISPLAY UNIT SOFTWARE**

2

3   In common with the monochrome display unit, the

4   colour display unit is designed to provide visual

5   prompts to a driver to supplement the audible

6   instructions issued by the in-vehicle device.

7

8   The colour display unit is capable of displaying

9   much more sophisticated graphics than the monochrome

10   display unit and in particular is not restricted to

11   pictographic displays but is also capable of

12   displaying coloured road maps showing the relative

13   position of the vehicle and nearby roundabouts and

14   junctions

15

16   As with the monochrome display unit, the colour

17   display unit has a number of display modes.

18   ·However, regardless of which display mode is

19   activated on the colour display unit, there is

20   always an area reserved at bottom of screen for

21   displaying:

22   (a)   the remaining distance to the destination

23   (b)   the estimated time of arrival at the

24   destination

25   (c)   an indication of whether traffic

26   congestion has been detected within the

27   map area displayed on the screen at any

28   given time

29

30   The display modes of the colour display function

31   include:

32   (A)   Map Display Mode

1   (B)   Guidance Active Mode

2   (C)   Guidance Inactive Mode

3   (D)   Help Mode

4

5   The display modes will be described in more detail

6   below.

7

8   **(A)   MAP DISPLAY MODE**

9

10   The principal display mode of the colour display

11   unit is the map display mode. The colour display

12   unit operates in map display mode even if the in-

13   vehicle device does not contain a navigation unit.

14   If the in-vehicle device does not contain a

15   navigation unit the colour display unit does not

16   display any navigation options. When operating in

17   map display mode, the colour display unit displays a

18   road map of the relevant country which can be zoomed

19   to different degrees of magnification in accordance

20   with user demands. In particular, the road maps can

21   be displayed at magnifications between 0.4 pixels

22   per mile (in which the entire UK mainland displayed

23   on the screen) and 100 pixels per mile (wherein the

24   screen width covers approximately 3 miles). At

25   higher levels of magnification, the map display

26   shows motorway and trunk road networks and

27   additional less significant roads.

28

29

30

31

32

1   MAP DISPLAY MODE MENUS

2

3   A number of functions are available to the user when

4   the colour display unit is operating in map display

5   mode, these functions can be divided into

6   (1)   basic functions

7   (2)   advanced functions

8   (3)   telephone functions

9

10   The advanced functions include the following:

11   (a)   a live traffic information function;

12   (b)   a current route display function;

13   (c)   a junction display function;

14   (d)   a compass aid function,

15   (e)   an exit indicator function; and

16   (f)   a safety camera warning function.

17   All the functions will be described in more detail

18   below.

19

20   1.   BASIC MAP DISPLAY MODE FUNCTIONS

21

22   The basic map display mode functions include a

23   vehicle location information function and an auto-

24   locate function. Both basic map display functions

25   will be described in turn below.

26

27   (a)   Vehicle Location Information

28   If a navigation unit is installed in the in-vehicle

29   device, the navigation unit can determine the GPS

30   location of the vehicle. The current GPS co-

31   ordinates of the vehicle are used to position a

32   vehicle icon on the currently displayed map, at a

1   point reflecting the current position of the vehicle

2   in relation to the map. The navigation unit can

3   also use acquired GPS data to determine whether or

4   not the vehicle is moving. If the vehicle is moving

5   the vehicle icon displayed on the current map is

6   depicted with an indication of the direction of

7   movement.

8

9   If the navigation unit cannot obtain a valid GPS fix

10   and thereby determine the current location of the

11   vehicle, the vehicle icon is displayed in accordance

12   with the most recent previously determined GPS

13   location of the vehicle. Vehicle icons are displayed

14   in one of two colours to enable a driver to

15   distinguish between vehicle icons displayed using a

16   current GPS fix and those using a previous GPS fix.

17

18   At all levels of zoom apart for the outermost (whole

19   of the relevant country), the map display is

20   provided with a pan option which enables the map to

21   be panned at the same level of zoom in one of eight

22   directions. To facilitate the panning operation, a

23   set of eight pan arrows is always displayed on a

24   map.

25

26   (b) Auto-Locate Function

27   In order to reduce the amount of required

28   interaction between the driver and the controls of

29   the colour display unit, the auto-locate function

30   can be used to automatically pan a displayed map, so

31   that the map tracks the location of the vehicle in

1 accordance with the most recently acquired GPS fix
2 of the vehicle.
3
4 When the auto-locate function is initiated, the user
5 may manually pan a displayed map until the
6 navigation unit obtains a first valid GPS fix for
7 the vehicle. Once a valid GPS fix is obtained, the
8 map is automatically panned so that vehicle is
9 positioned at the centre of the screen. If the
10 vehicle moves, the map is automatically panned to
11 keep the vehicle icon centred on the screen. The
12 zoom level of the map may be changed at any time
13 whilst the auto-locate function is activated, and
14 the auto-scrolling of the map will continue in
15 accordance with the movement of the vehicle.
16
17 If the auto-locate function is de-activated, the map
18 display will continue to update the vehicle position
19 on the map, but the map will no longer be
20 automatically panned in accordance with the movement
21 of the vehicle. Consequently depending on the
22 movement of the vehicle, the vehicle may move
23 outside the range of the currently displayed map, in
24 which case the vehicle icon will disappear from the
25 map display, unless the user manually pans the map
26 to compensate for the movement of the vehicle.
27
28 If the auto-locate function is not enabled, a
29 displayed map can be panned manually to track the
30 movement of the vehicle.
31

1   **2.   ADVANCED DISPLAY MODE FUNCTIONS**

2

3   (a)   Live Traffic Information Function

4

5   Traffic congestion is shown on a currently displayed

6   map using icons superimposed on the corresponding

7   locations on the map. The colour of a congestion

8   icon represents the degree of congestion at the

9   particular location relative to the free-flowing

10   traffic state. The number of congestion icons and

11   their distribution on a map indicate the extent of

12   the congestion within the geographical area

13   encompassed by the displayed map. The congestion

14   icon can also include a numeric representation of

15   the average speed of traffic at the affected

16   location, or alternatively a numeric representation

17   of the delay to be expected at the affected

18   location.

19

20   Congestion icons are designed to flash when

21   superimposed on a displayed map, to attract the

22   driver's attention and reveal map detail which may

23   be concealed beneath the icons. All of the

24   displayed congestion icons flash at the same rate.

25   However, when there are delays in both directions at

26   a particular location, the flashing of oppositely

27   disposed icons is sequenced, so that the congestion

28   in each direction is shown separately.

29

30   If a map were to be displayed at a low magnification

31   (i.e. low level of resolution) a normal congestion

32   icon might be shrunk to the extent that it would be

1   too small to be noticed by the driver. To overcome

2   this problem, a specialised LED style congestion

3   icon is used on maps displayed at low magnification.

4   Such LED style congestion icons do not contain

5   numerical information, but are instead colour coded

6   in accordance with the degree of traffic congestion

7   at a particular point.

8

9   (b)   Current Route Display Function

10

11 When a route has been downloaded to the in-vehicle

12 device it is displayed as a highlighted trace

13 superimposed on the currently displayed map.

14 Routing information may include roads that are not

15 held in the colour display unit map database and

16 these will be plotted based on vectors supplied by

17 the in-vehicle device's navigation unit. Once the

18 plotted journey is underway the highlighting on the

19 route will be greyed-out as the vehicle proceeds

20 along it.

21

22 In a ninth embodiment of the route guidance system,

23 the current route display function is intimately

24 linked with the previously described smart start

25 system and route convergence model. In order to

26 plot the current route of a vehicle, at any given

27 route key-point it is necessary to select and

28 display the branch which most closely reflects the

29 most recent manoeuvres of the vehicle.

30 Consequently, the current route display function

31 employs a dynamic selection and replotting algorithm

32 to provide a real-time display of the most suitable

1 route for the vehicle to its destination. The

2 process of selecting the most suitable branch for

3 the vehicle can be very broadly described in terms

4 of the following steps:

5 (i)   Before the navigation unit has determined

6   that the vehicle has reached one of the

7   route key-points, a "default" branch is

8   displayed by the colour display unit

9 (ii)   Once the navigation unit has determined

10   that the vehicle has reached a route key-

11   point on one of the branches, the current

12   route display function identifies the

13   branch corresponding to the reached route

14   key-point and the colour display unit

15   displays the path ahead to the next route

16   key-point on the branch

17 (iii) As the vehicle reaches further route key-

18   points, the current route display function

19   identifies its corresponding branch and

20   displays the path ahead to the next route

21   key-point on the branch.

22

23 If a number of branches emanate from the last route

24 key-point reached by the vehicle, a branch is

25 selected by the current route display function and

26 the next route key-point along the selected branch

27 is determined. The colour display unit then

28 displays the route ahead to the next route key-point

29 on the selected branch. If the vehicle passes this

30 route key-point, the current route display function

31 determines the next route key-point along the

32 present branch.

49

1   For example, consider the situation in which a

2   vehicle encounters a fork with two potential

3   branches $Branch_1$ and $Branch_2$. In this case the

4   current display function selects a branch, e.g.

5    $Branch_1$ and determines the next route key-point

6   along $Branch_1$, namely $Key\_point_{x,1}$. The current

7   display unit then displays the route ahead for the

8   vehicle from its current position at the fork to

9    $Key\_point_{x,1}$. If the navigation system determines

10   that the vehicle has passed $Key\_point_{x,1}$, the current

11   display function determines the next route key-point

12   along the branch, namely $Key\_point_{x+1,1}$.

13   However, if the initial route key-point on the

14   selected branch is not passed by the vehicle, it is

15   likely that the driver drove onto the branch which

16   was not selected and displayed by the current

17   display function. In this case, the current display

18   switches to the unselected branch and displays the

19   route ahead to the next route key-point on the newly

20   selected branch. Using the same example as before,

21   should the navigation unit determine that the

22   vehicle did not pass $Key\_point_{x,1}$, the current display

23   function switches to $Branch_2$ and displays the route

24   from the fork to $Key\_point_{x,2}$. If the vehicle passes

25   $Key\_point_{x,2}$ the current display function displays

26   the route ahead to the next route key-point on the

27   branch, namely $Key\_point_{x+1,2}$.

28

29

30

31

32

1   (c)   Junction Display Function

2

3   (i)   Simple Junctions

4   If a driver is approaching a junction, the junction

5   display function displays the junction in a

6   geographically-indicative pictogram similar to a

7   road-sign.   The pictograms essentially take the form

8   of the pictograms displayed by the monochrome

9   display unit (see Figures 5a and 5b)

10

11   If a vehicle passes a preparation point (e.g. 1 mile

12   in advance of a motorway junction), a pictogram

13   representing the junction is inset on a portion of

14   the currently displayed map and the navigation unit

15   issues an audible message, warning the driver of the

16   nearby junction.   The pictogram includes information

17   identifying the road which the driver should take

18   from the junction and an indication of the current

19   distance to the junction.

20

21   If the vehicle passes a warning point or an

22   instruction point (e.g. 400 yards in advance of a

23   junction) or a confirmation point (between

24   compounded junctions) a full-screen pictogram of the

25   junction is displayed unless suppressed by the

26   driver and a further audible warning message is

27   issued to the driver.

28

29   The full-screen pictogram of the junction includes

30   information identifying the name and/or number of

31   the **exit road** to be taken from the junction,

32   together with an indication of the class of the

1   exit-road. The pictogram also includes information
2   identifying the name and/or number of the current
3   i.e. **entry road** together with an indication of its
4   class. The full-screen pictogram finally includes
5   an indication of the current distance to the
6   junction.
7
8   Once the vehicle has passed the junction, the full-
9   screen pictogram of the junction is removed from the
10   colour display unit and the current map is re-
11   displayed to the driver. Similarly if the driver
12   deviates from the route to the junction, the
13   junction pictogram is removed and the current map is
14   re-displayed to the driver.
15
16
17   *(ii) Compound Junctions*
18
19   The colour display unit is also capable of
20   displaying compound junctions (in a similar way to
21   the monochrome display unit).
22   If successive junctions along a prescribed route are
23   located sufficiently close together it may not be
24   possible to place the normal full complement of
25   preparation points, warning points, instructions
26   points between them and it may be necessary to use a
27   restricted set of such route key-points to advise
28   the driver of the required manoeuvre. For example,
29   if a second turning is positioned within 600 yards
30   of a first turning, it may not be possible to place
31   a preparation point, warning point and instruction
32   point between the turnings and the motorist will

1   have to rely on the warning point and instruction

2   point messages. As the distance between successive

3   turnings decrease, the number of points available

4   for providing messages to users also decrease. In

5   extreme cases, there may not be enough space to

6   place any preparation points, warning points,

7   instruction points between successive junctions.

8

9   In the circumstance where junctions are located so

10   close together that it is not possible to place any

11   route key-points between the corresponding manoeuvre

12   points, the junctions are shown in the full-screen

13   pictogram as a compound series (as shown in Figure

14   8). The colour display unit can display a compound

15   series comprising two junctions of any type or up to

16   two roundabouts combined with one radial junction.

17   As a car approaches one of these compound junctions,

18   the colour display unit displays a full-screen

19   pictogram of the entire compound series. The full-

20   screen pictogram also displays text identifying the

21   name or number of the entry road to the first

22   junction and the name or number of the exit road

23   from the last junction of the compound series. A

24   compound instruction such as "turn right and then

25   immediately turn left" is issued at the instruction

26   point before the first manoeuvre.

27

28   As the car passes through the first junction of the

29   compound series and approaches each later junction,

30   the full-screen pictogram only displays the sub-

31   junction in question.

32

1   To ensure display of the next pictogram as soon as
2   possible after negotiating the first junction, the
3   display reverts to a map once the first candidate
4   route point has been reached after any compound
5   manoeuvre. A maximum of three junctions can be
6   compounded in this manner.
7
8   (iii)   Un-encoded Junctions
9   Depending on the optimal route determined by the
10   central route advisory system, the driver may merely
11   be required to drive straight through a junction
12   (i.e. neither turn right nor left, nor turn around a
13   roundabout).
14
15   In these cases the navigation server neither encodes
16   speech nor pictograms for the junction and merely
17   places confirmation points around the junction to
18   detect whether the driver has turned on the junction
19   rather than going straight through it and as a
20   result has driven the car "off-route" (i.e. the
21   navigation server only places confirmation points
22   around the un-encoded junctions for off-route
23   detection). These unencoded junctions may be
24   recognised via their "CP-triplet" signature (as
25   previously described).
26
27   (d) Compass Aid Function
28
29   Should a driver lose his way from a pre-defined
30   optimal route, audible instructions to the driver
31   are often not very helpful for assisting the driver
32   to regain his route. Similarly, should the driver

1 change his mind as to his desired destination,

2 audible instructions are not very helpful for

3 enabling a driver to lock on to a new route.

4

5 In these circumstances, the compass aid function

6 provides an indicator in the form of an inset onto

7 the currently displayed map showing a dart pointing

8 to the nearest route key-point marker. On reaching

9 this marker, the optimal route to the desired

10 destination is re-calculated and displayed.

11

12 The processing algorithm for the Compass Aid

13 proceeds as follows:

14 1. While Guidance is active but the vehicle is **not**

15 on-route, on passing a route point the in-vehicle

16 device determines the "best" route key-point within

17 the current scanning window for (re)gaining the

18 prescribed route as follows;

19 2. If there are no candidate route key-points (i.e.

20 none within the speed-dependent matching radius)

21 then a successor of the nearest route key-point is

22 used (see 4 below);

23 3. If candidate route key-points are found (i.e.

24 within the speed-dependent matching radius) then a

25 successor of the candidate with the highest

26 "benefit" (i.e. considering both proximity and

27 alignment) is used;

28 4. In both cases 2,3, the "best" (to be pointed at)

29 is the first route key-point at least 30 yards from

30 the current vehicle position found by tracing

31 successors along the relevant "branch";

1   5. The in-vehicle device calculates the angle

2   between the current GPS heading and the azimuth of

3   the selected "best" route key-point, and sends this

4   angle to the display unit which responds by

5   displaying a dart graphic with 16 possible

6   orientations;

7

8   The compass aid function has two further modes of

9   operation, namely manual and automatic re-routing

10   modes.

11

12   In automatic re-routing mode, once the in-vehicle

13   device detects that the user has driven off a

14   prescribed route, the in-vehicle device initiates a

15   silent call to the central route advisory system (ie

16   without alerting the user). If during the call, the

17   in-vehicle device detects that the user has re-

18   gained the prescribed route, the silent call is

19   terminated without making the user aware of the

20   activities of the in-vehicle device. However, if

21   the in-vehicle device detects that the user has not

22   regained the prescribed route, it issues a beep to

23   warn the user and a new route is calculated based on

24   the current position of the vehicle.

25

26   In manual re-routing mode, if the in-vehicle device

27   detects that the user has driven off the prescribed

28   route, it will issue an audible warning to the user,

29   for example, "no longer on route, please do a U-turn

30   where safe". However, if the user is unable to

31   safely perform the U-turn, the user may manually

1   initiate a re-route request call to the central

2   route advisory system.

3

4   (e)   Exit Indicator Function

5

6   Exit indicators provide an enhanced visual

7   indication of the exit direction from roundabouts

8   and radial un-encoded junctions.

9

10   The exit indicators dynamically change according to

11   the movements of the vehicle at the relevant

12   junction. In the case of a roundabout, the exit

13   indicator moves around the circular pictogram

14   (representing the roundabout) as the vehicle itself

15   moves around the roundabout. In the case of a

16   radial junction, the exit indicator is adjusted as

17   the vehicle approaches the junction.

18

19   (f)   Safety Camera Warning Function

20

21   The navigation unit uses this function to generate

22   audible warnings to the driver of nearby road-side

23   speed cameras. In addition, the colour display unit

24   displays an icon depicting the camera and an

25   indication of the speed limit relevant to the

26   camera.

27   3.   TELEPHONE FUNCTIONS

28

29   Calls to the call centre are not regarded as "user"

30   voice calls because the in-vehicle navigation unit

31   always follows up such calls with a data call to the

32   central route advisory system.

1   The colour display unit provides a user interface to

2   enable a driver to use the in-vehicle mobile

3   telephone device to make and receive conventional

4   voice-calls. The in-vehicle mobile telephone device

5   can also be used to receive text messages which can

6   be displayed on the colour display unit. These

7   facilities are made possible by the telephone

8   functions of the colour display unit.

9

10   The telephone functions can be broadly divided into

11   functions for making and receiving voice calls and

12   functions for receiving and displaying text

13   messages. These functions will be described in more

14   detail below.

15

16   **(a)   Voice Calls**

17

18   The telephone: voice calls function enables a user

19   to use the touch screen of the colour display unit

20   as a telephone keypad similar to the keypad of a

21   conventional mobile phone. The colour display unit

22   telephone keypad may then be used as a user-

23   interface to the in-vehicle mobile telephone device

24   to enable the driver to make a voice call to a

25   desired telephone number.

26

27   On activating the telephone option the user is

28   provided with the following functions:

29   (a)   **Keypad**

30   Converts the colour display unit touch screen

31   into a telephone key-pad. As a number is

32   entered by the driver, the number is displayed

1		on the colour display unit.
2	(b)	**Store and Recall**
3		The mobile telephone device in the in-vehicle
4		device includes a memory for storing up to ten
5		frequently used telephone numbers. Each of
6		these numbers has an associated single digit
7		identifier. The store function enables a user
8		to store a number in the mobile telephone
9		device memory in which case the stored number
10		is automatically allocated a number which acts
11		as its identifier. The user can display a
12		stored number using the recall function
13		together with the single digit identifier. The
14		recalled number can then be dialled using the
15		call function.
16	(c)	**Recall**
17	(d)	**Call**
18		Submits the number entered by the driver to the
19		mobile telephone device for dialling. If the
20		recipient telephone system is engaged, the call
21		function is switched to a redial mode, until
22		the user exits the telephone function menu.
23		Alternatively, if the call is connected to the
24		recipient, the "store" and "recall" functions
25		are suppressed.
26	(e)	**Delete**
27		Removes individual digits from an entry or the
28		entire entry itself.
29		
30		The above functions enable a driver to make a call
31		from the in-vehicle device. However, the in-vehicle
32		device may also be used to receive calls from

1   external sources. In this case, the colour display

2   unit displays the telephone number of the incoming

3   call and the driver is provided with the option to

4   accept or reject the call.

5

6   <u>Suppression of Spoken Instructions</u>

7   During a voice call or the ringing of the in-vehicle

8   device's mobile phone (on receipt of an incoming

9   telephone call)the in-vehicle device cannot play

10   audible instructions to the driver because the in-

11   vehicle device's audio output is being used for the

12   voice call. In circumstances such as this, the

13   normal instruction playback functions of the in-

14   vehicle device are suppressed in favour of the

15   ongoing voice call. When it is necessary for the

16   navigation unit to provide guidance instructions

17   etc. to the driver, the navigation unit generates a

18   discreet alert tone, whereupon the driver can use a

19   repeat function to interrupt the voice call (without

20   disconnecting the caller). In this case, the

21   navigation unit temporarily takes over control of

22   the audio system of the in-vehicle device to repeat

23   the instruction to the driver. When the instruction

24   message is completed, the navigation unit releases

25   control of the audio system to the audio system.

26

27   Should the driver not wish to interrupt the current

28   voice-call with the guidance instruction from the

29   navigation unit, the driver may continue with the

30   voice call and once the call has ended, use the

31   repeat function to repeat the last instruction.

32

1 <u>SOS Facility</u>

2 The in-vehicle device software includes an optional

3 facility to enable a user to call for assistance in

4 cases of emergency and breakdown and to transmit an

5 SMS message indicating the location of the caller to

6 the operator of the emergency service. On

7 initiating the SOS call, any active calls to the in-

8 vehicle device (user voice calls, calls to the

9 central route advisory system or route uploads) are

10 terminated immediately.

11

12 **(b)   Text Messaging**

13

14 The in-vehicle can also display text-based

15 information of the following categories:

16 (a)   Incident

17 (b)   Text Messages

18

19 **(a) Incident Information**

20 Text based "incident" messages may be transmitted to

21 a driver as a supplement to the icon based display

22 of traffic delays. These "incident" messages convey

23 specific incident information, e.g. relating to

24 accidents or road closures. The information is

25 encoded to relate to specific geographical areas

26 within the country and the user will only be alerted

27 to the incident if it is relevant to the currently

28 displayed map area.

29

30 **(b) Text Messages**

31 As discussed above, the in-vehicle device may

32 display received SMS messages. SMS messages from

1   certain designated sources are used solely by the

2   navigation unit and are not displayed to the user.

3   Messages from any other sources are deemed

4   "personal" and displayed to the user. Up to 10 SMS

5   messages may be stored in a non-volatile memory

6   associated with the in-vehicle device mobile

7   telephone.

8

9   Both the textual content of any stored SMS messages

10   and the CLI (phone number) of the caller can be

11   displayed together with an icon indicating whether

12   the message has been read or not.

13

14   **B.   GUIDANCE ACTIVE MODE**

15

16   In guidance active mode, the navigation device

17   actively advises the user of the optimal route to a

18   required destination. The touch-screen of the

19   colour display unit thus acts as a user interface to

20   the in-vehicle navigation unit enabling the user to

21   make a manual voice call to the central route

22   advisory system before commencing a journey

23   requesting routing advice to the desired

24   destination.

25

26   Furthermore, the user can use the touch screen of

27   the colour display unit to request a new route to

28   the destination even if the vehicle is progressing

29   along a previously downloaded optimal route to the

30   destination. In this case the navigation unit

31   cancels the old route and continues with the new

32   route.

1   In addition, if the driver has deviated from the

2   previously prescribed route, the driver can request

3   the route guidance system to prepare a new route to

4   the required destination, using the re-route

5   function.

6

7   Finally, the driver can reversibly mute audible

8   guidance or traffic-related instructions. In this

9   case the in-vehicle navigation unit continues

10   scanning and matching route key-points but

11   suppresses off-route re-route processing and the

12   display of junction pictograms.

13

14   **C.   INACTIVE GUIDANCE MODE**

15

16   In the guidance inactive screen mode the user can

17   obtain guidance instructions to a particular

18   destination with making a manual call to the central

19   route advisory system. In this case, route requests

20   are made automatically by the in-vehicle device in

21   accordance with the request of the user.

22

23   In particular a driver may request a route to a

24   destination selected from a set of saved favourite

25   destinations. In this case the selected destination

26   is transmitted to the navigation server (without

27   requiring human operator intervention) and after

28   validating the destination, the server automatically

29   transmits the route to the in-vehicle navigation

30   unit.

31

1 Similarly, the user may request a route to a

2 previously visited destination. In use a navigation

3 unit of an in-vehicle device stores in an on-board

4 memory, the latitude and longitudes of the most

5 recent previously requested destination. When the

6 driver selects the previous destination option, the

7 latitude and longitude of the destination are

8 automatically transmitted to the navigation server

9 which transmits an appropriate route to the in-

10 vehicle device navigation unit.

11

12 It will be understood that since the vehicle's

13 location may have changed since the request was made

14 for a route to the previous destination and the

15 prevailing traffic conditions may have also changed,

16 that the route transmitted by the navigation system

17 server may differ from the route previously

18 suggested to the destination.

19

20 Finally, the driver may identify a destination

21 according to its post-code. In this case the post-

22 code is automatically transmitted to the navigation

23 server (without requiring human operator

24 intervention) and the route is automatically

25 transmitted back to the driver's navigation unit.

26

27   **D. HELP MODE**

28

29 When the colour display unit is operating in help

30 mode, the user can customise the sounds produced by

31 the in-vehicle device. For example, the user can

32 enable or disable the sounding of a warning tone

64

1   when a text message is received by the in-vehicle

2   device and can also change the volume of audible

3   warning messages

4

5   Similarly, the user can customise the guidance menus

6   displayed by the colour display unit, so for

7   example, the colour display unit may be directed to

8   display pictographic representations of junctions

9   only and suppress the display of map information.

10   Furthermore, the user can also customise screen and

11   display attributes.

12

13   This invention is not limited to the embodiments

14   herein described which can be varied in construction

15   and detail.